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Open File Report 90-17

EVALUATION OF VERTI-PRESS PRESSURE FILTER FOR LEAD CONCENTRATE DEWATERING

by

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Brunswick Mining and Smelting Corporation Limited

Canada-New Brunswick Mineral Development Agreement
Entente Canada-Nouveau-Brunswick L'Exploitation Minérale

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EVALUATION OF VERTI-PRESS PRESSURE FILTER

FOR LEAD CONCENTRATE DEWATERING

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1.0 INTRODUCTION

1.1 Objective

The objective of the project was to evaluate the potential of a Verti-Press pressure filter for the dewatering of a fine-grained lead sulphide concentrate produced by Brunswick Mining and Smelting Corporation Limited (BMS).

1.2 Scope

The testwork was directed towards two primary concerns: firstly, to operate the machine in an industrial environment to evaluate the reliability of the design; secondly, to compare performance with other pressure filters and provide data for design and scale-up to production levels. A preliminary economic evaluation of the equipment was also completed.

1.3 Background

Pressure filter technology was introduced to the North American mining industry in the past decade in the form of continuous batching machinery from several offshore manufacturers. These machines offered considerable benefits in terms of reduced energy costs when compared to conventional equipment, which normally consists of a vacuum filter in series with a fossil-fueled thermal dryer. A number of conversions and new installations have been made, including three Larox units in the concentrator of BMS. These first generation filters have produced an excellent filter cake but reliability has been poor and maintenance costs have been high. BMS remains committed to the concept of pressure filtration but is keenly interested in the development of an improved pressure filter which will become the standard for dewatering of base metal concentrates in the future.

2.0 EXPERIMENTAL SET-UP AND PROCEDURE

2.1 Concentrator Installation

A general description of the Verti-press filter design and operation is included as Appendix I. A 0.93 m^2 (10 ft^2) single chamber machine rented from the manufacturer was mounted over an existing lead concentrate vacuum filter discharge belt conveyor. Slurry from the lead thickener circulating pump at 55-70% solids (by weight) was directed to the filter by a centrifugal slurry pump. This system was arranged in an automated loop such that the circulating pump ran continuously and returned slurry to the thickener discharge pump box whenever the filter was not in the feed portion of its cycle. Filter cake was discharged onto the conveyor via a chute. The filter cycle was controlled by a programmable logic controller supplied with the unit.

The filter was operated over a three week period, primarily during the day shift. Operation was monitored at regular intervals for necessary adjustments, potential problem areas, and breakdowns.

The procedure for process testing was based on measurement of relevant operating parameters over a single filter cycle. Three sets of tests were conducted while varying the critical parameters of diaphragm press time and drying air blow time. Moisture analysis of the feed slurry and filter cake was determined by drying the product at 150°C. Air flows and pressures were read from a rotameter and pressure gauge mounted on the filter. Cycle times were measured manually with a stop watch. The filter cake weight was calculated using a sample of known area and measured thickness from each end of the test batch.

2.2 Filtra-Systems Ltd. Test Facility

The test filter was refitted to produce a thicker filter cake. This required a modification to the end seals to allow the additional clearance necessary to discharge the thicker cake.

The filter set-up was for limited operation. Lead concentrate was provided in 200 l (45 gal) drums. A small mechanical mixer was used to homogenize the slurry, and it was fed to the filter by a drum-mounted submersible pump. Filter cake was discharged into a box. After several batches the dry cake was returned to the drum and reslurried. The entire batch was weighed to determine batch weight. Only tne drying air blow time was varied. In other respects the procedures were similar to the concentrator tests. A total of 11 sets of data were obtained to determine the effect of filter cake thickness on operating parameters.

3.0 RESULTS AND DISCUSSIONS

3.1 Reliability

In general the filter ran very reliably after start up adjustments were completed, and suffered no breakdowns.

One mechanical problem was encountered during commissioning. Fragments of filter cake tended to break away from the cake edge and build up in the end seal seat during cloth advance in the discharge cycle. This caused the seal to leak during the next cycle. The problem was resolved by directing additional sprays into the seat area.

Settling solids filled the 5.1 cm (2 inch) deep filtrate collection pan over 8 hours operation, requiring manual cleaning. The flat pan on the test unit was not equipped with sprays and had only one 5.1 cm (2 inch) diameter outlet. The filtrate collection pan will require redesign for processing slurries containing dense mineral particles.

3.2 Process Capability:

An accepted approach to filter analysis involves determination of production rate per unit of filter area and an air factor (F_a) which is defined as follows:

$$F_a = \frac{\text{Air Blow Rate } (Nm^3/m^2/min) \times \text{Blowing Time (minutes)}}{\text{Filtration Rate } (t/h/m^2)}$$

The air factor is typically plotted against filter cake moisture, and the curve determined from small scale tests is used for equipment selection, design and scale up. The typical curve will asymptotically approach a limiting moisture level. Equipment is generally chosen to operate beyond the knee of the curve to ensure stable product moisture under varying process conditions. This method could not be directly applied to the Verti-Press test data obtained from the concentrator installation for several reasons. Air flow rate during the cake drying portion of the cycle is critical in the calculation of F_a. Indicated air flow rates were so low on the rotameter scale that the readings were considered to be unreliable. In addition, process variation resulted in substantial changes in the feed slurry density. The simplified control system on the test filter could not compensate for this variation and filter cake thickness varied as a result. The Verti-Press test unit was capable of producing a maximum cake thickness of only 20 mm (0.75 inch). In order for equipment of this type to be economically feasible on a production scale, a minimum cake thickness of approximately 30 mm (1.13 inches) minimum is required to achieve adequate production capacity. On the basis

of the test data it was not possible to reliably determine F_a for a production size filter cake thickness.

The tests did indicate that the Verti-Press can produce a filter cake of adequate dryness (6-7% moisture by weight) and that the process curve is similar to the traditional curves for both vacuum and pressure filtration.[1,2] Figure 1 shows the data plotted together with earlier data from Larox pilot pressure filter tests on zinc concentrate. The process curve for the Verti-Press filter was calculated assuming a drying air flow rate of 0.76 Nm^3/min (25 SCFM). Higher values for air flow would shift the curve to the right.

Production rate for the machine with a 20 mm cake was approximately 0.45 t/h/m^2 of filter area. Total filter cycle time was approximately 8 minutes. The miscellaneous time was approximately 4.5 minutes as detailed in Table 1. This time was much longer than expected and indicates a possible malfunction with the pumping system which provided water for opening and closing of the seals and inflation of the cake pressing diaphragm.

The second series of tests carried out at the Filtra- Systems Ltd. test facility in Michigan confirmed the potential of the machine. Prior to operation, the air flow meter was replaced with a unit calibrated for lower air flows. The seal and diaphragm pumping system was also overhauled to reduce the miscellaneous pumping cycle time.

Data from the latter tests is shown in Table 2, and the air factor F_a is plotted against filter cake moisture in Figure 2. These results indicate that the Verti-Press will stabilize at 5.5% cake moisture with 15 Nm^3/t/h of drying air and will produce 0.64 t/h/m^2 of product at a cake thickness of 30 mm (1.13 inches). This cake moisture is 0.5-1.0% lower than for similar Larox pilot pressure filter tests. With appropriate adjustments to filter operating parameters the Verti-Press filter should be capable of producing 0.76-0.78 t/h/m^2 at 6.0-6.5% moisture by weight with an air flow rate of 6-8 Nm^3/t/h.

3.3 Additional Comments

The Verti-Press filter has several features which distinguish it from other similar equipment presently on the market. The mechanical design is much less complicated than other types. It has far fewer components and nearly all are standard items available from North American suppliers. All unique parts are readily fabricated and there are no castings. Standard electrical components are of North American manufacture and the equipment can be provided with electrical components of the customer's choice. The filter chamber is much deeper than competitive models which means that a full batch can be pumped into the chamber without the need for partial cake dewatering

during the feed cycle via filtrate flow through the filter belt. Only compression of the air in the chamber is necessary. Unfortunately feed pump pressures were not recorded during the tests but it is clear that this design will require lower pressures than for competing filters which require prefiltration during the feed cycle. This feature could have significant benefits in terms of feed pump wear and maintenance since the combination of high head and high slurry density is well known to be very detrimental to pump service life.

The Verti-Press is also optionally available in a form where a multichamber machine could continue to operate with one or more chambers shut down. This feature is not available or in fact possible with any other unit available today and would constitute a major advantage for continuous production industries where unscheduled breakdowns are extremely costly.

3.4 Economic Comparison

Purchase cost of a Verti-Press filter is comparable to that of a Larox filter of equal size. However, on a cost per tonne basis, the Verti-Press would be 15-20% less costly due to its higher unit production capacity. The independent chamber operation option might also permit selection of a smaller machine since it would affect the availability factor which is critical in establishing production machinery sizes. The overall mechanical simplicity will result in lower costs and inventories for spare parts and reduced maintenance labour costs.

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

1. The Verti-Press filter has considerable promise for applications to base metal concentrates.
2. It is mechanically much simpler than the various other types presently on the market and therefore has potential for better availability and reduced maintenance.
3. Unit production rates will exceed those of the Larox filter due to a shorter filter cycle time.
4. Energy requirements will be somewhat lower due to reduced air consumption.
5. There is potential for reduced feed pump horsepower and wear rates due to lower required feed pressure.
6. There is potential for reduced capital, operating and maintenance costs.

4.2 Recommendations

The Verti-Press filter in the 50 sq. ft./chamber format should be considered very seriously for future filter applications on Brunswick and similar concentrates.

5.0 REFERENCES

1. J.E. Nesset, "Dewatering Brunswick Concentrates by Pressure Filtration" CIM Bulletin v. 75, n. 843, pp.103-112.
2. D.A. Dahlstrom, "How to Select and Size Filters", Mineral Processing Plant Design, A.L. Mular and R.B. Bhappu, eds., AIME pp. 578-600.

TABLE 1 - VERTI-PRESS TEST RESULTS (B.M.&S. CONCENTRATOR, DECEMBER 1986)

Date	Squeeze Time	Air Blow Time (Min:Sec)	Air Blow Press.(psi)	Indicated Air Flow Feed ($Ft.^3/Ft.^2$/ Min)	Feed Time(Sec)	Misc Time (Min:Sec) (4)	Cycle Time (Min:Sec)	Feed Density, % Sol.	Cake Thick (mm)	Moisture (%)	Loading (Kg/m^2) (1)	Air Flow $m^3/min/m^2$ (3)	Filt.Rate mtph/m	Fa $m^3/mtph$
Dec.3/86	15	1:30	95	5.0	Not recorded	Not recorded	5:54	55.1	10	6.8	36.7	1.516	.357	6.37
	15	1:30	90	4.0	"	"	5:48	55.9	10	7.4	38.8	1.212	.399	4.56
Dec.22/86	15	1:30	100	5.0	"	"	6:30	59.2	10-12	8.3	39.1	1.516	.361	6.29
	15	1:30	95	2.5	"	"	6:30	Not Measured	15	8.4	44.4	0.758	.410	2.77
	15	1:00	100	5.0	"	"	5:54	64.8	15	9.3	48.0	1.516	.480	3.16
Dec.23/86	15	1:30	80	0 (2)	"	"	7:48	69.9	15-16	8.8	48.3	0.758	.371	3.07
	30	1:00	90	0	"	"	7:12	Not Measured	13-15	8.1	45.8	0.758	.383	1.98
	30	2:00	95	0	"	"	8:18	69.4	18-19	7.2	59.9	0.758	.431	3.52
	30	2:30	100	0	20	4:28	7:54	Not Measured	20	6.2	58.4	0.758	.451	4.20
	45	2:30	100	0	28	4:35	8:18	68.4	18-20	6.95	59.4	0.758	.429	4.41
	45	1:30	95	0	32	4:37	7:24	Not Measured	20	7.2	59.7	0.758	.486	2.34
	45	1:00	100	0	28	4:17	6:30	67.9	20	7.6	59.4	0.758	.551	1.38
	45	2:00	100	0	20	4:49	7:54	Not Measured	20	6.9	60.0	0.758	.459	3.31

(1) Filter area = 103 ft^2 = 0.95 m^2
(2) Meter Reading unreliable
(3) Calculated based on assumed air flow of 25 SCFM (2.43 S.C.F.M./Ft^2)
(4) Misc time includes: Header flush, air vent, seal inflation, belt movement, seal retraction and dewatering

FIGURE 1: Process Curves

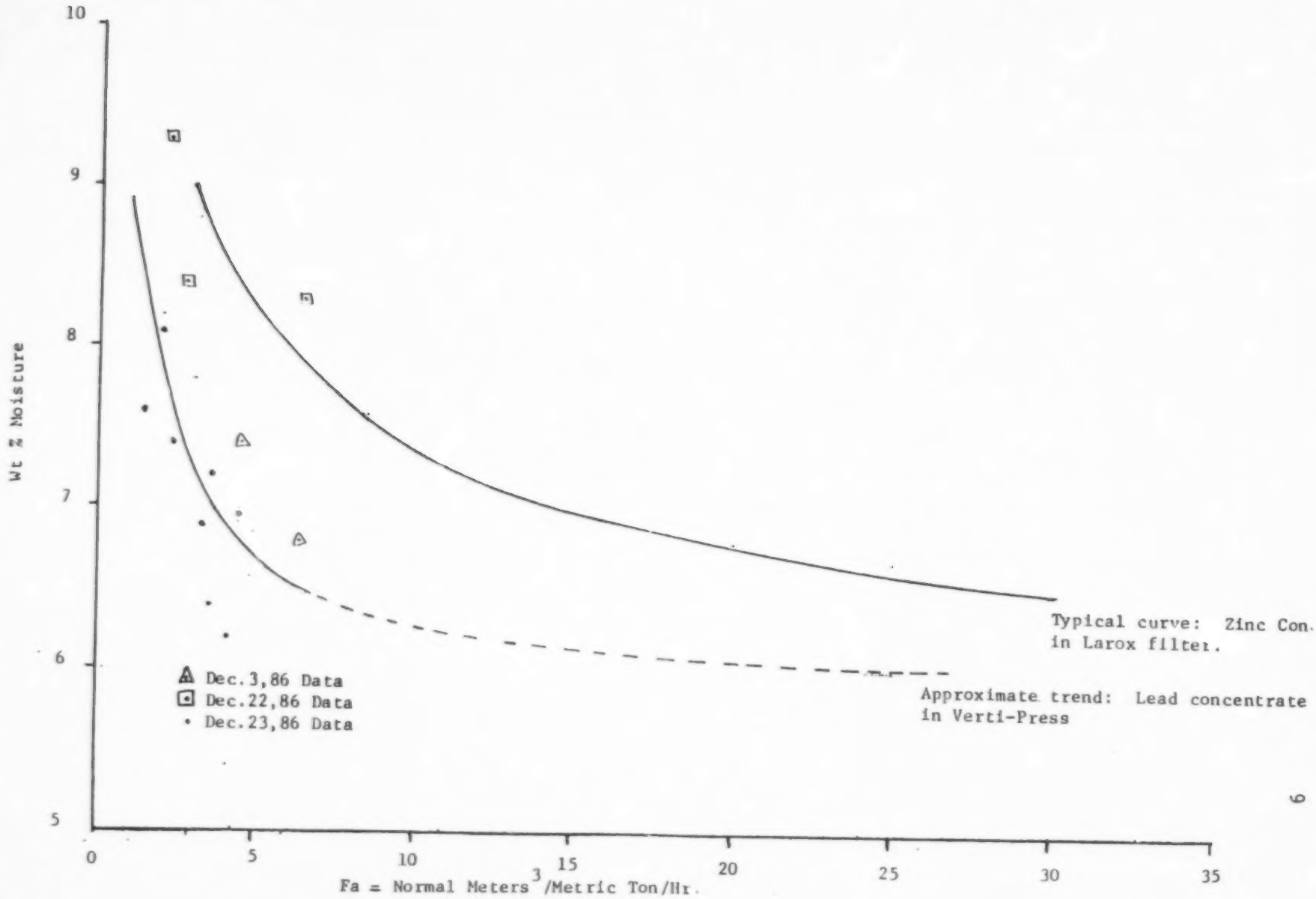


TABLE 2: VERTI-PRESS PILOT PLANT TEST RESULTS: BRUNSWICK LEAD CONCENTRATE FILTRA SYSTEMS LTD. JUNE 1-5, 1987

FEED TIME	DEWATERING TIME	SQUEEZE TIME	AIRBLOW TIME	MISC TIME	TOTAL CYCLE TIME	EQUIVALENT TIME †	AVG. AIR FLOW STD CONDITIONS		CAKE THICKNESS		MOISTURE	LOADING		PRODUCTION RATE (DRY)		P_a
sec	min:sec	sec	min:sec	min:sec	min:sec	min:sec	$\frac{ft^3}{ft^2}{min}$	$\frac{m^3}{m^2}{min}$	(Inch)	(mm)	%	$\frac{\#}{ft^2}$	$\frac{kg}{m^2}$	$\frac{\#}{ft^2 hr}$	$\frac{mt\,ph}{m^2}$	$\frac{Nm^3}{mt\,ph}$
26	2:35	30	0:15	1:36	5:22	7:07	3.88	1.18	1.15	29.2	8.1	19.0	92.8	212.5	1.038	0.29
28	2:24	30	0:30	1:43	5:35	7:05	5.83	1.78	1.13	28.6	7.4	17.4	85.2	187.4	0.915	0.96
30	2:20	30	1:00	1:40	6:00	7:00	6.31	1.92	1.07	27.1	7.1	16.2	79.3	162.3	0.793	2.42
29	2:28	30	1:30	1:38	6:35	7:05	6.80	2.07	1.20	30.5	6.9	19.9	97.1	181.2	0.885	3.51
33	2:20	30	2:00	1:41	7:04	7:04	7.28	2.22	1.13	28.7	5.9	18.6	91.0	158.3	0.772	5.75
30	2:20	30	2:00	1:40	7:00	7:00	7.28	2.22	1.13	28.7	5.8	18.7	91.1	159.9	0.781	5.69
30	2:19	30	2:00	1:37	6:56	6:56	7.28	2.22	1.09	27.8	5.8	18.1	88.4	156.7	0.765	5.80
35	2:21	30	2:00	1:40	7:06	7:06	7.28	2.22	1.16	29.4	6.2	18.9	92.2	160.1	0.782	5.68
30	2:30	30	3:00	1:42	8:12	7:12	7.77	2.38	1.20	30.5	5.8	19.2	93.7	140.5	0.686	10.41
29	2:30	30	4:00	1:39	9:08	7:08	7.77	2.38	1.19	30.1	5.4	19.8	96.8	130.3	0.636	14.97
30	2:30	30	5:00	1:38	10:08	7:08	7.77	2.38	1.13	28.7	5.4	18.8	91.9	111.5	0.544	21.88

† "Equivalent time" is the total cycle time if a 2 min. airblow had been used. (It is given to review the consistancy of the results.

- Loading was determined by weighing the entire discharged filter cake (10.3 ft^2/.0957 m^2)
- Airflow was measured with a headland flowmeter, mounted on the filter, reading in the middle of its range
- Miscellaneous time includes: header flush, air vent, seal inflation, belt movement, seal retraction
- Airblow pressure was held constant at 100 PSI during the entire airblow

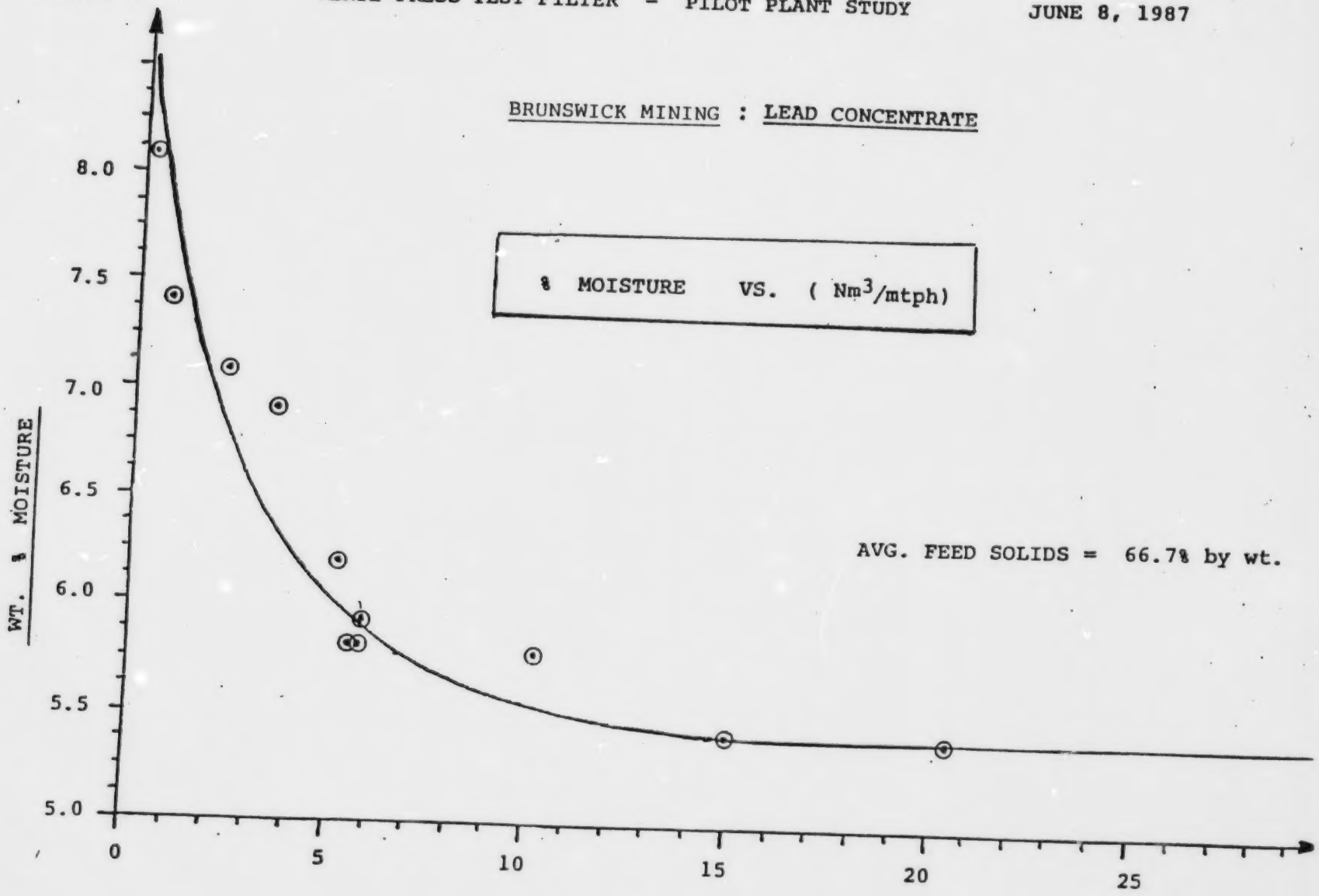
FIGURE 2

VERTI-PRESS TEST FILTER - PILOT PLANT STUDY

JUNE 8, 1987

BRUNSWICK MINING : LEAD CONCENTRATE

% MOISTURE VS. (Nm^3/mtph)



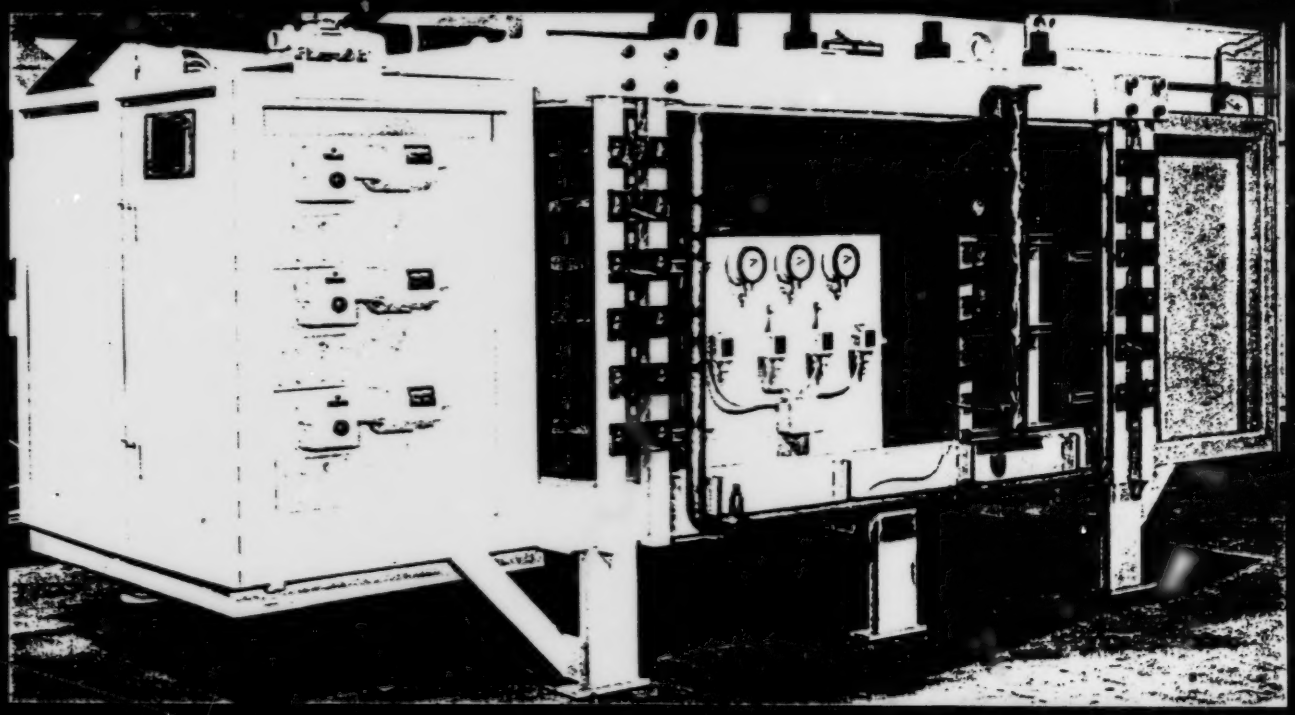
AVG. FEED SOLIDS = 66.7% by wt.

F_A = NORMAL METERS ^{3}/METRIC TON/HR.

APPENDIX I

12

VERTI-PRESS



A Breakthrough In Liquid/Solid Separation

FILTRA-SYSTEMS
Filtration Systems Technology

10 REASONS

WHY THE VERTI-PRESS REDUCES SEPARATION COSTS

1 EXTREMELY DRY CAKES. Dual-head air squeeze [illegible] 94% solids [illegible] dner than conventional diaphragm filter [illegible] and frame filter or belt presses.

2 SHORT CYCLE TIMES. The VERTI-PRESS can [illegible] fast as five minutes discharge to discharge [illegible] drum directly in [illegible] 52 tons [illegible]

3 FULLY WASHED CAKES. The filter cakes are formed in the filter chamber by a filter belt. This assures that the cakes are positively discharged [illegible] cycle. All phases of the filter [illegible] controlled by a programmable controller to provide the speed for optimum operating results.

4 VERTICAL RESISTANCE. Vertical stacking of the horizontal filter chambers allows for maximum use of plant space and leads to improved cake washing efficiency. Horizontal positioning of the filter cakes assures uniformly constant thickness, homogenous structure and equal flow resistance. All these factors lead to highly efficient cake washing and minimum wash water consumption.

5 SINGLE POINT CAKE DISCHARGE. All of the [illegible] discharge the filter cakes at one location. This greatly simplifies the cake handling equipment and allows for simpler and lower cost [illegible]

6 ENERGY EFFICIENT DESIGN. Filter sealing [illegible] and dewatering are done hydraulically to minimize energy consumption. The use of only compressed air is minimized or eliminated completely.

7 SIMPLE DESIGN. Unlike conventional pressure filters which require complex mechanisms to open and close the filter plates, the VERTI-PRESS has few moving parts. The filter chambers are stationary. Filter sealing is accomplished simply by inflating the seals in each of the filter chamber. The only other moving parts in the filter are the diaphragms at the filter cloth. All filter cloths are individual and can be [illegible] in minutes without the need to [illegible]

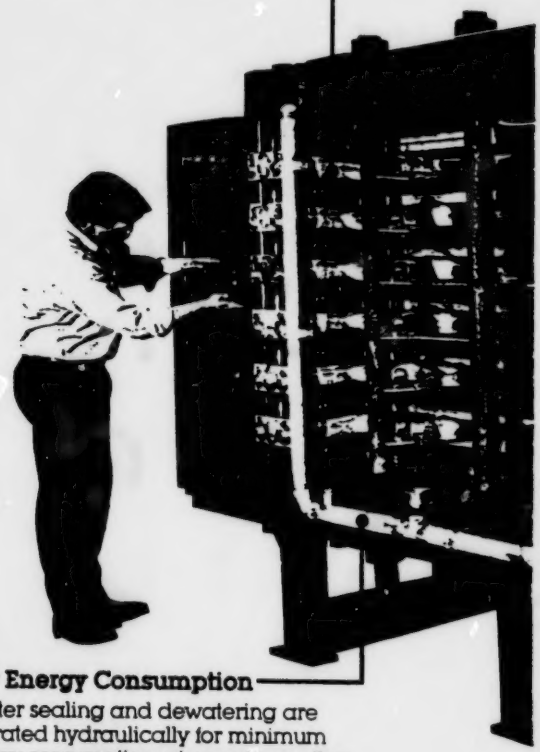
8 [illegible] All filters are fully assembled, pressure tested and [illegible] at the factory. Filters are [illegible] reducing installation time and cost.

9 [illegible] with [illegible] system. All [illegible] each [illegible] reduced maintenance costs.

10 [illegible] built in the USA.

Minimum of Moving Parts

The unique and patented inflatable seal moves—the filter is stationary. This means lower maintenance cost and fewer parts to buy. The result—lower cost of operation.

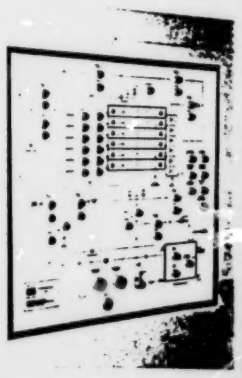


Low Energy Consumption

Filter sealing and dewatering are operated hydraulically for minimum energy consumption using water or other liquid as a working fluid. The filter is capable of operating without compressed air. All of these VERTI-PRESS features lead to lower operating costs.

Fully Automatic Operation

Operation of the VERTI-PRESS filter is completely automatic. Control systems are provided to customer specifications and include solid state programmable controllers and graphic displays. Variables such as filtration time and cake squeeze time are easily adjusted.



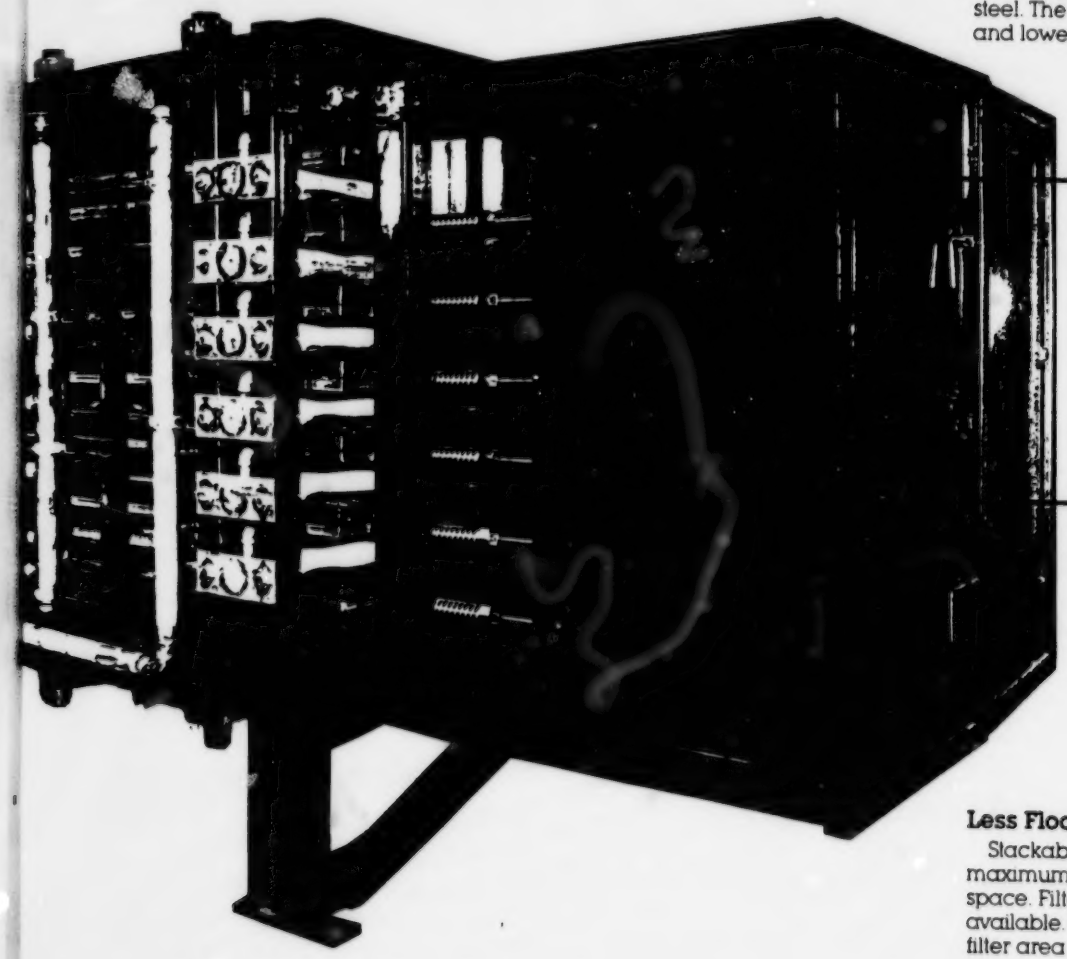
VERTI-PRESS

Diaphragm Dewatering System

A diaphragm in each filter module is hydraulically pressed against the sludge cake at 100 psi to insure a dry cake discharge.

Corrosion Resistant Construction

All wetted parts are of corrosion resistant construction – primarily stainless steel. The result is longer equipment life and lower operating costs.



Positive Cake Discharge

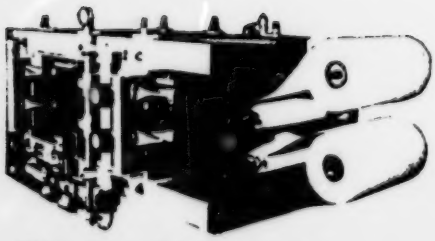
The dewatered cake is carried from the filter chamber via permanent conveyorized filter belts and discharged. Since an operator is not required, operating costs are greatly reduced.

Single Cake Discharge Point

Simplifies cake handling and reduces cost.

Less Floor Space Needed

Stackable filter modules provide maximum filter area in minimum floor space. Filter areas of 10-600 ft.² are available. Field retrofit to add additional filter area is possible.



Disposable Media Option

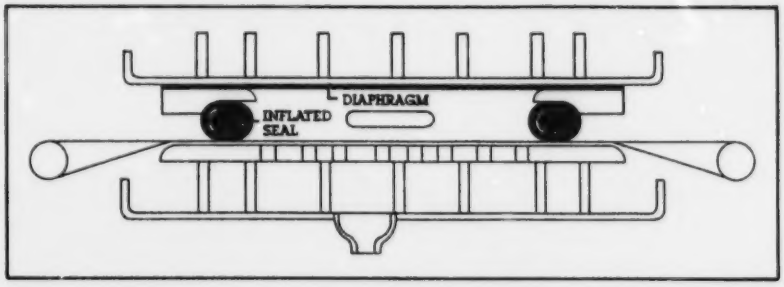
The VERTI-PRESS can be easily and quickly converted for use with disposable media if required.

Other advantages of the VERTI-PRESS include . . .

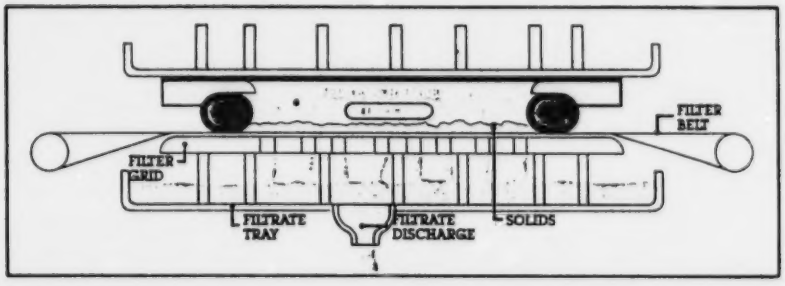
- **Individually replaceable filter belts**
- **Individually replaceable filter seals**
- **Optional high efficiency cake wash**
- **Optional filter cake air drying system**
- **Adaptability to a wide range of flow rates**

Sequence of Operation

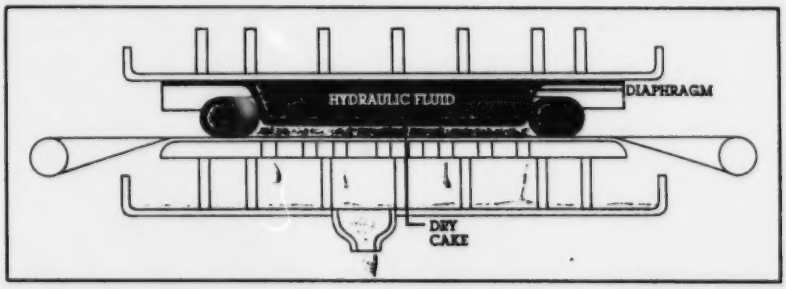
1. Seals are hydraulically inflated to 150 psi to close the filter chambers.



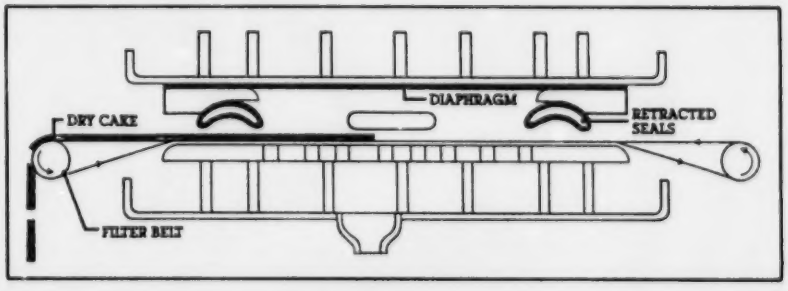
2. Slurry is pumped under pressure into the filter chamber. Solids are retained on the filter belt. The liquid drains through the filter grid into the filtrate tray. Liquid flows from the filtrate tray by gravity to be collected in a common header.



3. After optimum cake formation height is established, remaining liquid is squeezed from the cake by pressing with the diaphragm using 100 psi hydraulic pressure.



4. After cake pressing is complete, the diaphragm and seals are retracted and the cake is removed from the filter by moving the filter belt.

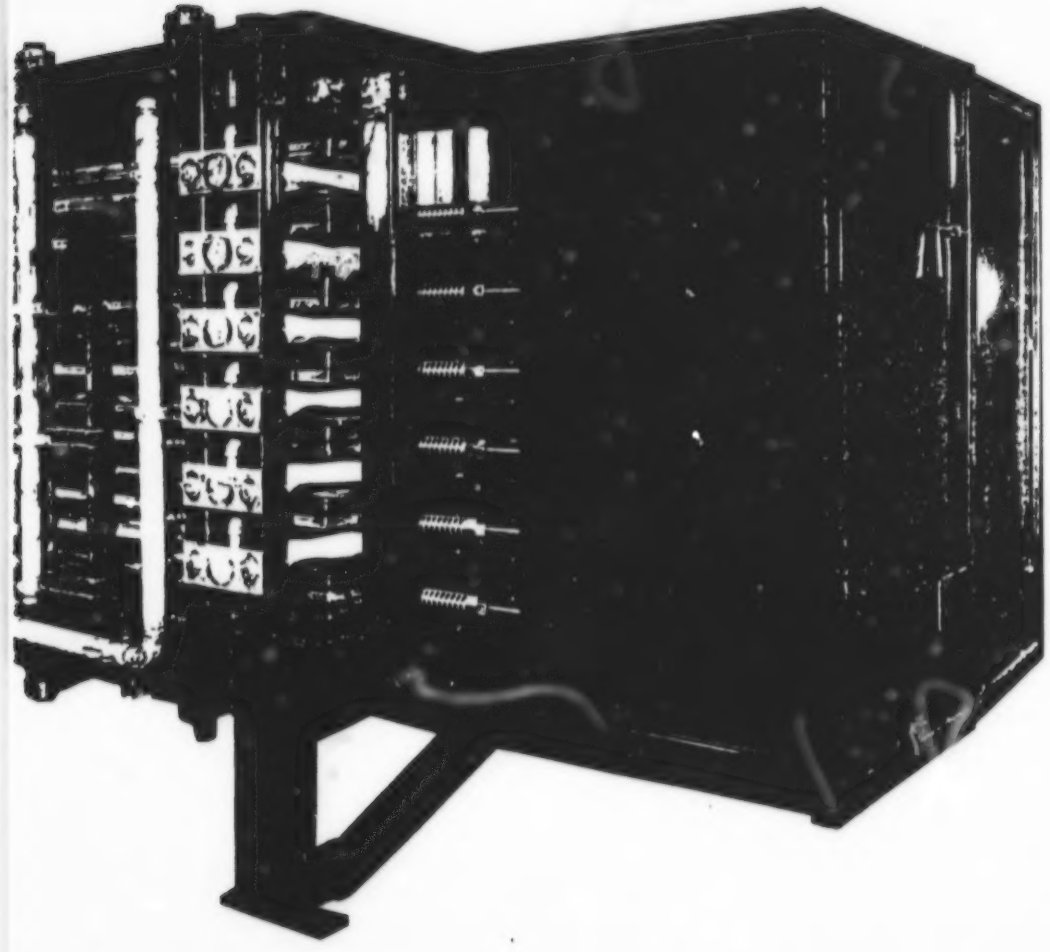


The versatility of the VERTI-PRESS filter makes it ideal for a wide range of applications in chemical processing, food processing, potable water, mining operations, high purity water systems, pollution control, pulp and paper, and many other industries.

We have complete laboratory facilities to process and analyze your samples. Our laboratory can produce predictable results with samples as small as 5 gallons. Larger prototype units are available for tests at our plant or at your site.

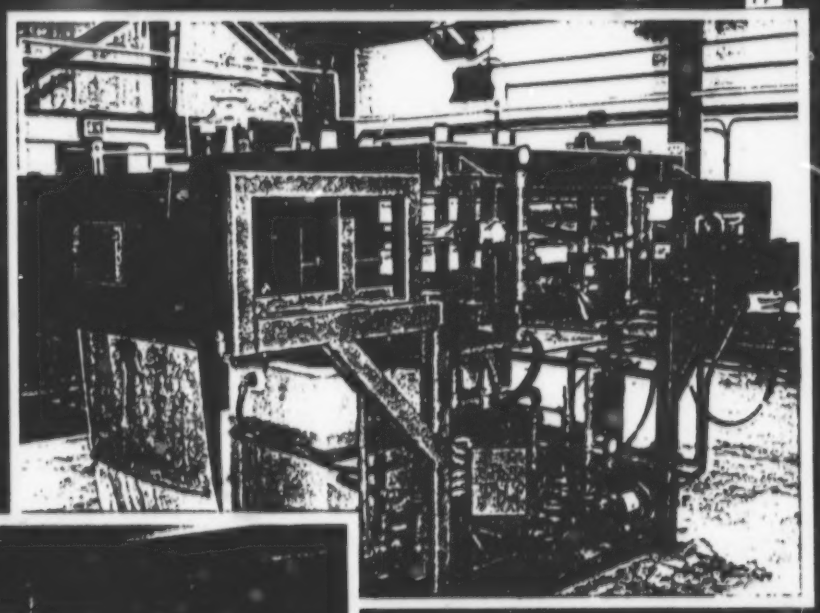
Call us. We're confident that when your entire processing cost in calculated, VERTI-PRESS becomes your most economical filter because of automation, energy efficiency, dry cake discharge, and the host of other benefits.

VERTI-PRESS A Revolutionary High Pressure Filter With Unmatched Versatility

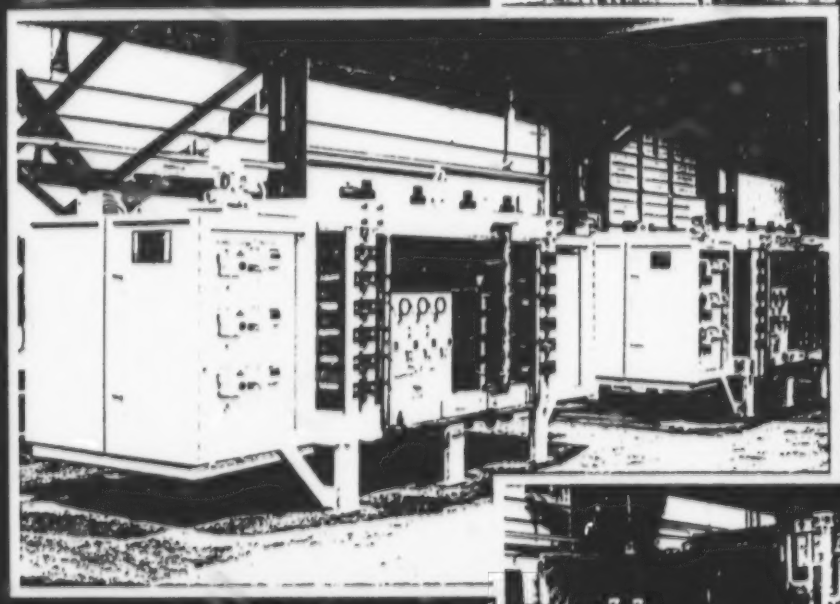


UP TO 94% CAKE SOLIDS
PRODUCTION RATES TO 100,000 LBS./HR.
FLOW RATES TO 2,000 GPM
FILTER AREAS TO 600 FT^2

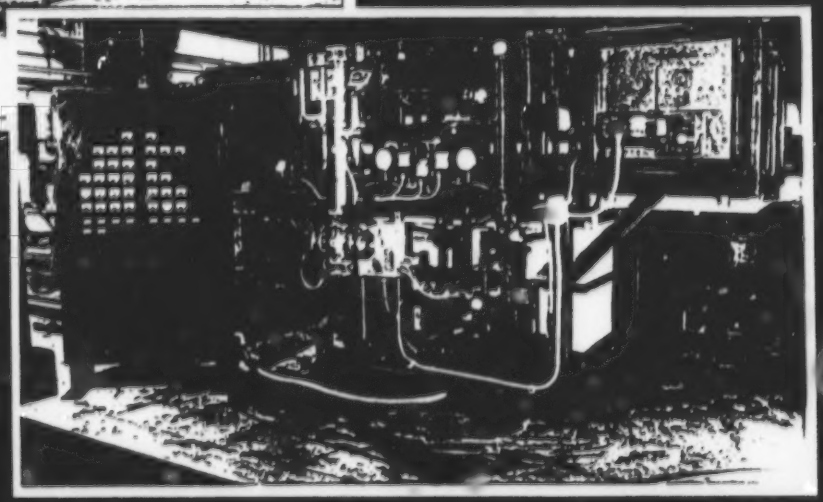
- Fully Automatic Operation
- Single Point Cake Discharge
- Corrosion-proof Construction
- Low Energy Consumption
- Diaphragm Liquid/Solid Separation
- High Speed Cycle



Model VP-10-1 VERTI-PRESS for tin plating solution at 150 F. ph 14



Two 150 ft² filters for—
1. Specialty chemical dewatering employing high efficiency cake wash system.
2. Biological waste treatment sludge dewatering.



Single chamber 10 ft³ fully automatic demonstration unit. Available on a rental basis for site testing.

FILTRA SYSTEMS

Printed in U.S.A.